Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(A)**	**Attempt any THREE:**		**12 M**
	(a)	**Define i. Rainfall ii. Run off iii. Rainfall intensity iv. Yield** **Ans.** **i. Rainfall –** Rainfall is the depth in mm or cm of water that would stand on the surface of the earth provided it were not lost by evaporation or absorption or any other manner. **ii. Run off –** The amount of water which flows over the surface of the earth after considering all losses is called as runoff **iii. Rainfall intensity-** A maximum rainfall during a short period measured in mm/ hr is called rainfall intensity. **iv. Yield-** Yield of drainage basin is defined as, the total quantity of water available from a catchment area at the outlet in the period of one year.	**1 M** **1 M** **1 M** **1 M**	**4 M**
	(b)	**Explain four factors affecting runoff.** **Ans.** Following are the different factors which affect runoff :- **1)Rainfall characteristics :** a. More the rainfall, runoff will be more. b. More the intensity of rainfall, More will be the runoff. **2) Topography:** a. It depends upon smoothness and roughness of the surface b. Steep slopes – Heavy runoff will reach the valley quickly, reducing losses gives more runoff. c. catchment is mountainous, more will be runoff d. catchment is in windward direction, more will be runoff	**1 mark each (any four)**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(b)**	**3) shape and size of catchment –** a. Catchment area – Larger the area, more runoff b. Fan shaped catchment gives greater runoff **4) Characteristics of catchment :** a. Rocky strata – heavy runoff b. Compactive strata - heavy runoff c. Sandy strata – reduced runoff d. if more area of catchment is cultivated ,surface runoff will be less. e. Presence of vegetation covers reduces the runoff during smaller storm. **5) Meterological characteristics :-** a. Low temperature – greater runoff b. High temperature– less runoff **6) Geological characteristics :-** a. pervious soil – reduces runoff b. porous and fissure rock – very low surface runoff		**4 M**
	(c)	**Calculate yield and maximum flood discharge from catchment 60 km^2, having average annual rainfall 760mm by using Inglish formula.** **Ans.** Given, A = 60 km^2 Rainfall = 760 mm To find- Yield = ? Max. flood discharge- ? **Solution-** By using Inglish Formula $Q = \frac{123A}{\sqrt{A+10.4}}$ $Q = \frac{123 \times 60}{\sqrt{60+10.4}}$ **Q = 879.57 m^3/sec** Average annual rainfall= 760 mm < 200cm So, The area is non ghat area $R = \frac{P(P-17.78)}{254}$ $R = \frac{76(76-17.78)}{254}$ **R = 17.42 cm** Yield = R x C.A Yield =17.42 cm x 60 km^2 =17.42 x 10^{-2} x (60 x 10^6) / 10^4 Ha.m **Yield = 1045.92Ha.m**	**1 M** **1 M** **1 M** **1 M**	**4 M**

Q.1 (d) What is crop season ? name crop seasons adopted in Maharashtra with their respective periods — 4 M

Ans.

Crop season- It is seasonal period in which crop takes from the instant of its sowing to that of its harvest. — 1 M

In Maharashtra there are two principle seasons- Kharif and Rabi

For the rest of country, There are three crop seasons- Hot, Winter and mansoon

Crop seasons adopted in Maharashtra- — 3 M

Sr. no.	Season	Period	
		From	To
1	Kharif	15 June	14 oct
2	Rabi	15 oct	14 feb
3	Hot weather	15 feb	14 June
4	Eight monthly	15 June	14 feb
5	Annual	15 June	14 June

(B) Attempt any <u>One:</u> — 6 M

(a) Calculate the average annual rainfall of a catchment , from the following data by using Arithmetic mean method and Theissons polygon method

Area of polygon (Ha)	**100**	**150**	**200**	**75**	**125**	**400**
Rainfall in mm	**600**	**550**	**650**	**580**	**620**	**700**

Also calculate dependable yield from above catchment at 60% dependability. Take runoff coefficient 0.45.

Ans.

Arithmetic mean method- — 1 M

Average annual rainfall =∑P/N

Average annual rainfall = (600+550+650+580+620+700)/6 — 1 M

Average annual rainfall = 616.66 mm

Theissons polygon method-

Average annual rainfall = (∑AP) / ∑A — 1 M

$$P = \frac{(100x600 + 150x550 + 200x650 + 75x580 + 125x620 + 400x700)}{100 + 150 + 200 + 75 + 125 + 400}$$

P = 641.42 mm — 1 M

Arranging rainfall at descending order-

Area of polygon (Ha)	**400**	**200**	**125**	**100**	**75**	**150**
Rainfall in mm	**700**	**650**	**620**	**600**	**580**	**550**

The 60% dependable rainfall comes at Sr. No. = 6 x 60/100 = 3.6

P = (620 + 600) /2 = 610 mm — 1 M

Runoff = 0.45 x 610 x 10^{-3} m = 0.2745m

CA = 400+200+125+100+75+150 = 1050 Ha

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(a)**	Yield = CA x Runoff Yield = 1050 x 0.45 x 610 x 10^{-3} = 288.225 Ha.m	**1 M**	**6 M**
	(b)	**Fix the control levels DSL, FRL, HFL and TBL from the following data** **i. Effective storage required = 3000 Ha.m** **ii. Carry over allowance and tank losses = 25%** **iii. Dead storage = 10% of gross storage**		

Contour RL (m)	**580**	**582**	**584**	**610**	**612**	**614**
Storage (Mm^3)	**3.0**	**4.5**	**6.0**	**30**	**40**	**50**

Assume flood lift as 1.5 m and free board as 2.5m.

Ans.

Gross storage = dead storage + live storage

Live storage= eff. Storage +tank losses +carry over allowance

Live storage= 3000+ (25/100)x3000

Live storage= 3750 Ha.m = 37.5 $M.m^3$ — **1 M**

Gross storage = 10/100 x gross storage + 37.5

0.9 Gross storage = 37.5

Gross storage = 37.5/0.9 = 41.66 $M.m^3$ — **1 M**

$$FRL = 612 + \frac{(614-612)(41.66-40)}{(50-40)}$$

FRL =612.332 m — **1 M**

Dead storage=10/100 x Gross storage =10/100 x 41.66 = **4.166 $M.m^3$**

$$DSL = 580 + \frac{(582-580)(4.166-3.0)}{(4.5-3)}$$

DSL = 581.55 m — **1 M**

HFL = FRL + flood lift

HFL = 612.332 +1.5

HFL = 613.832 m — **1 M**

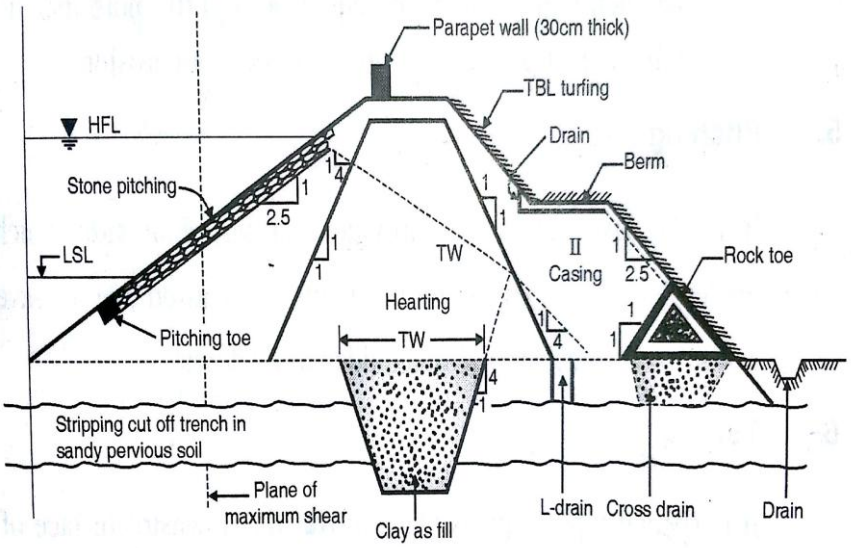
TBL = HFL + Free Board

TBL = 613.832 + 2.5

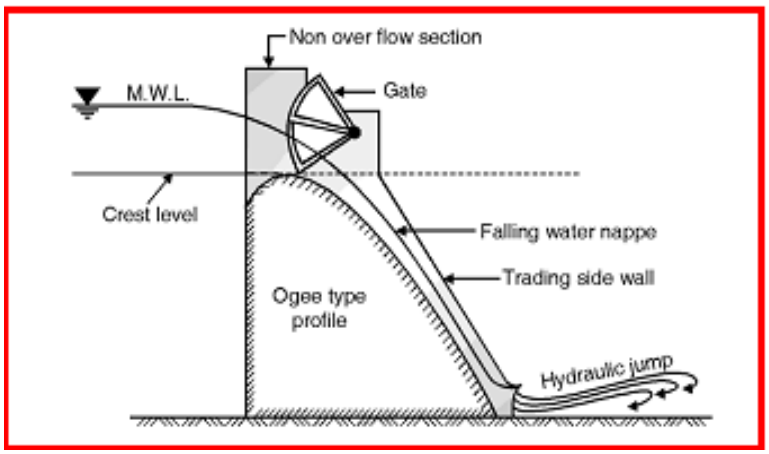
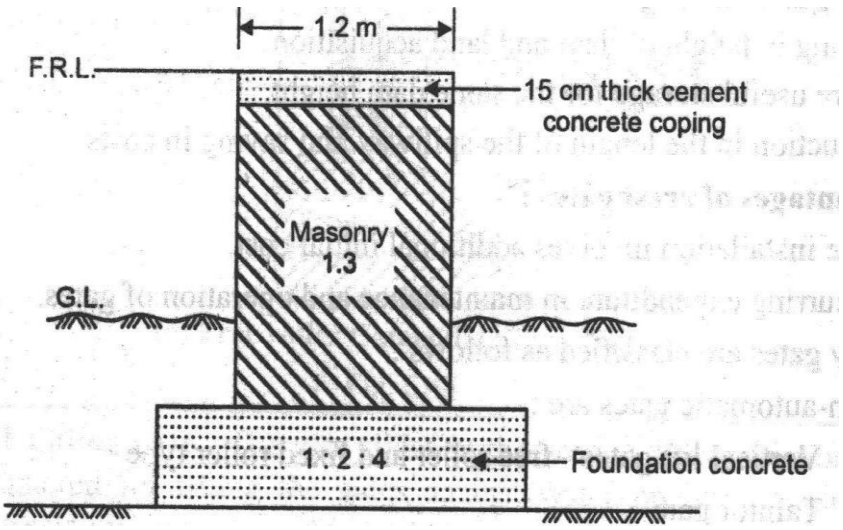
TBL = 616.332 m — **1 M** — **6 M**

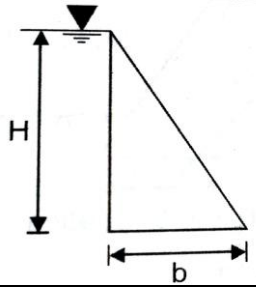
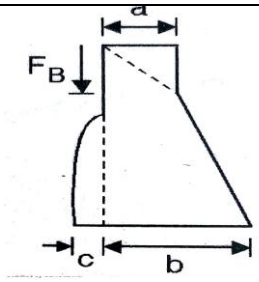
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2		**Attempt any <u>FOUR</u> :**		**16 M**
	(a)	**Explain the various engineering surveys to be conducted for an irrigation project. Enlist data to be collected for the same.** **Ans.** **Engineering surveys –** In this type of surveys or investigations, various types of surveys e.g. plane table survey, traverse survey aerial and photographic survey etc. are carried out. The aim of this type of survey is to prepare a contoured map or topographic map. The contour map will furnish the following necessary information- 1. Water spread 2. Arrangement of lines of communication 3. Capacity of reservoir 4. Suitable dam site 5. Site for waste weir and outlets 6. Area elevation curve 7. Storage elevation curve 8. Map of the area to indicate the land property to be surveyed **Data to be collected for Irrigation project-** **1.** Size of catchment (area in Km^2) **2.** Area under cultivation, under forest and under habitation **3.** Type of soil **4.** Existing ponds and size , their capacities **5.** River sites in that area. **6.** Flood levels if available from past record if any **7.** Slope of hills **8.** Contour survey of reservoir basin **9.** Gauging of rivers **10.** Availability of materials of construction **11.** Sedimentation problem **12.** Trial pits and boring at dam site **13.** Soil survey for commanded area **14.** Details of land being submerged and rehabilitation problems	**2 M** **1/2 M Each (any four)**	**4 M**
	(b)	**Describe four factors affecting the rate of silting with suggestive control measures.** **Ans.** Factors affecting silting are- **1. Catchment area-** Fan shaped catchment, the amount of deposition of finer soil fractions will be more as compared to fern shaped catchment **2. Slope of country-** If slope is steep , more particles are deposited through runoff as velocity is more which carries silt and clay particles with it and high velocity may erode soil more **3. Beginning of storing water in reservoir-** Most of the silt is usually washed down by first heavy storms. **4. Nature of surface soil-** If the soil is loose then silting is more as more particles will move along with runoff.	**½ mark each (any four)**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**(b)**	5. **Rainfall characteristics-** Rate of silting is depends on the nature of rainfall and is intensity **Sedimentation in reservoirs can be controlled by following methods-** 1. The catchment area is less errodable 2. Constructing check dams across the streams contributing water to the reservoir 3. Providing contour trenches on the steep and hilly slopes of tcatchment 4. Designing the reservoir properly causing the escape of silty water. 5. Dredging the silt from reservoir	**½ mark each (any four)**	**4 M**
	(c)	**List the eight types of repairs and maintenance works for an earthen dam.** **Ans.** Following are the repairs and maintenance work for an earthen dam- 1. Maintenance of pitching 2. Checking of upstream slope 3. Checking of downstream slope 4. Checking of Berms 5. Repairing of Turfings 6. Maintenance of rock toe 7. Maintenance of drain 8. Checking of top of dam including parapet wall	**½ marks each**	**4 M**

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.2</td><td>d)</td><td>Draw neat labelled sketchof zoned type of earthen dam. Write names to component parts of earthen dam.
Ans.
 
</td><td>2 marks for labeling

2 marks for neat sketch</td><td>4 M</td></tr>
<tr><td></td><td>e)</td><td>Give four points of comparison between earthen and gravity dam with respect to foundation, seepage, construction and maintenance.
Ans.
<table>
<tr><th>Criteria</th><th>Earthen dam</th><th>Gravity dam</th></tr>
<tr><td>Foundation</td><td>They can be founded on any soil</td><td>They cannot be founded on any soil without proper foundation</td></tr>
<tr><td>Seepage</td><td>There is more seepage through the body of the dam and it’s foundation compared to gravity dam</td><td>Comparatively there is less seepage in case of gravity dam</td></tr>
<tr><td>Construction</td><td>1.For its construction skilled labours are not required
2.Construction cost of earthen dam is less
3.For earth dams the diversion of flow during construction is costly</td><td>1.For its construction skilled labours are required
2.Construction cost of gravity dam is more
3. the diversion of flow during construction of gravity dam is costly</td></tr>
<tr><td>Maintenance</td><td>Maintenance cost of earthen dam is more</td><td>Maintenance cost of gravity dam is less</td></tr>
</table></td><td>1 Marks each</td><td>4 M</td></tr>
</table>

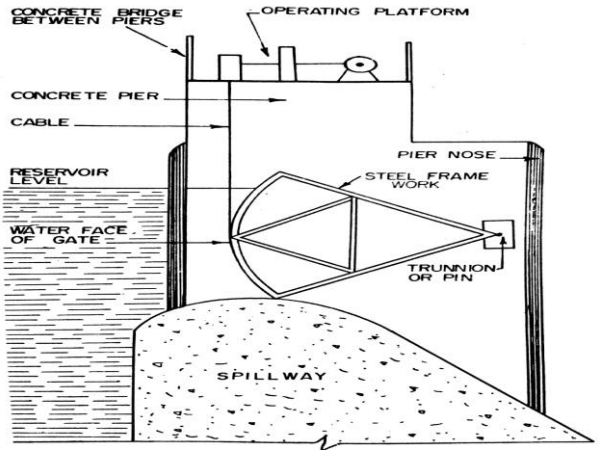
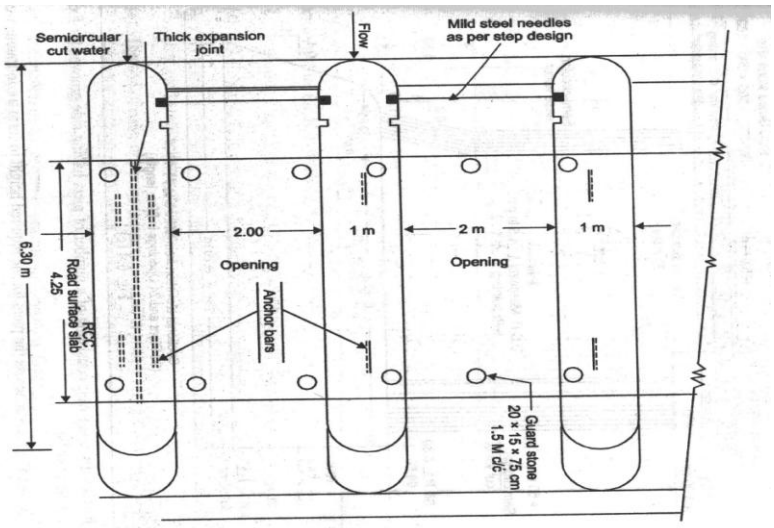
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	(f)	**Define – spillway and write two functions of spillway. Also draw neat cross section of ogee spillway and bar type spillway.** **Ans.** **Spillway-** It is an arrangement provided at the crest of dam to expel the excess water rises above the full reservoir level. **Functions of spillway-** **1.** To effectively dispose off the surplus quantity of water from upstream to downstream side of the reservoir. **Ogee spillway-**  **Bar type spillway-**  	**1 M** **1 M** **1 M** **1 M**	**4 M**

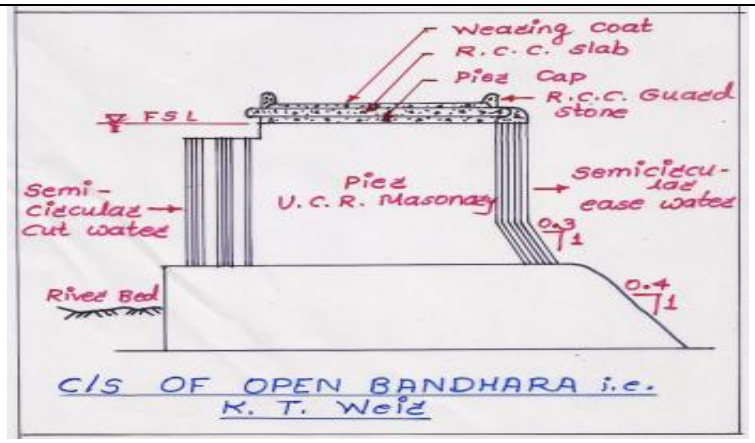
<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.3</td><td>(a)</td><td>Attempt any FOUR
Differentiate between theoretical and practical profile of gravity dam.
Ans.
<table>
<tr><th>Sr. no.</th><th>Elementary profile</th><th>Practical profile</th></tr>
<tr><td>1</td><td>Provision of free board is not provided.</td><td>Provision of free board is provided.</td></tr>
<tr><td>2</td><td>Road way at top is not possible.</td><td>Road way at top is possible.</td></tr>
<tr><td>3</td><td>For reservoir empty condition it will provide maximum possible stability.</td><td>For reservoir empty condition tension is developed at toe and hence some masonry is provided on u/s side.</td></tr>
<tr><td>4</td><td> 
</td><td> 
</td></tr>
</table></td><td>1 mark each</td><td>16 M

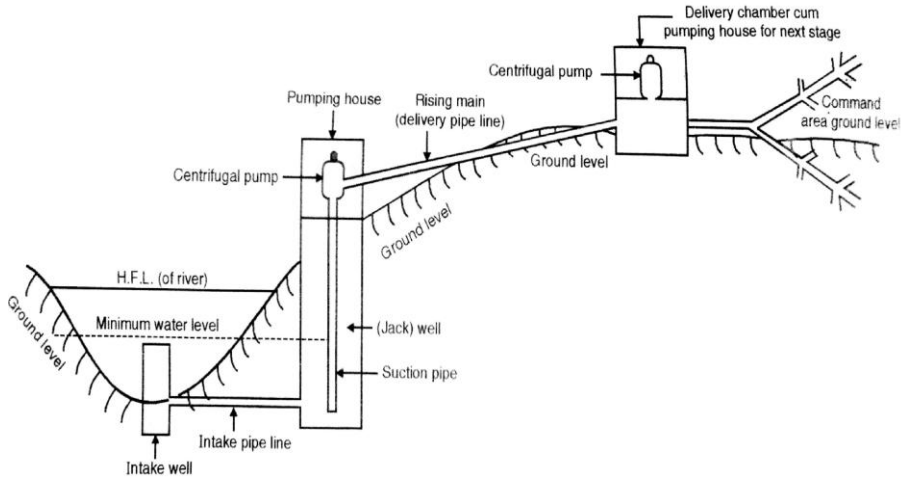
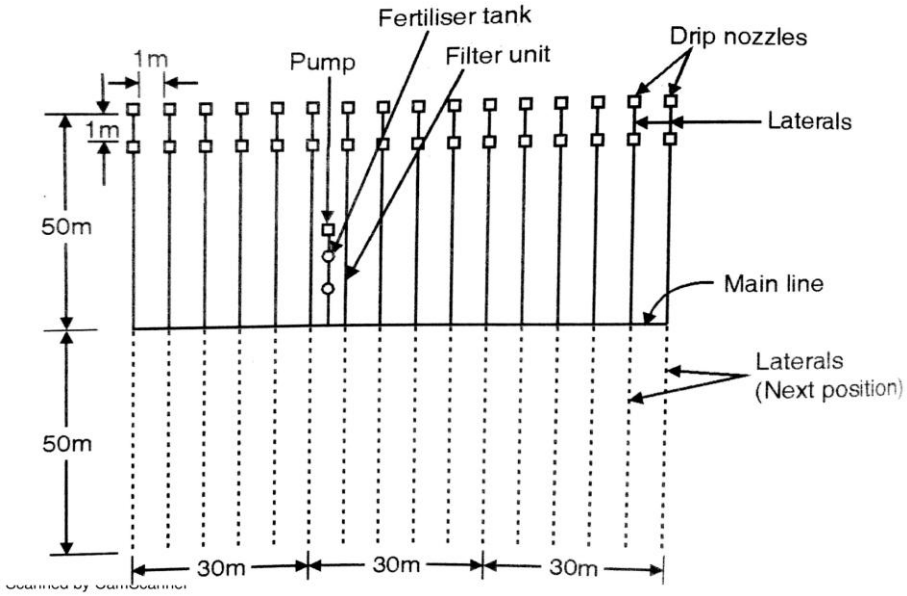
4 M</td></tr>
<tr><td></td><td>(b)</td><td>Explain the importance of drainage gallery and joints in gravity dams.
Ans.
Importance of drainage gallery:
1) For inspection of dam from inside.
2) To drain off seepage water through the body of dam.
3) It provides access to spillway gate.
4) It helps in locating pumps, observation devices.
5) It provides access for grouting.

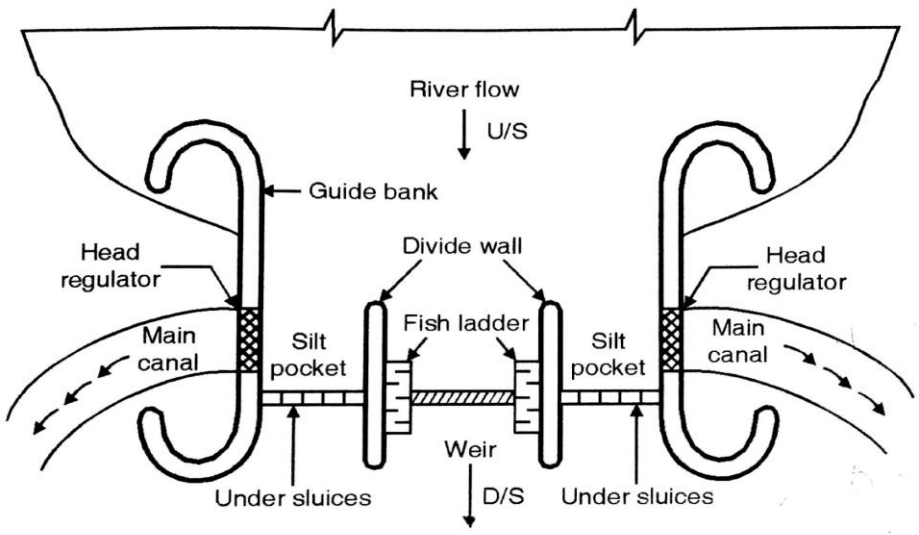
Importance of joints:
1) Construction joints are used for opposing contraction stresses.
2) Construction joints are provided for ease in construction of dam.
3) Contraction joints helps to reduce tensile stresses formed in concrete and temperature variations.
4) Transverse joints allow contraction and prevent cracks in the dam.</td><td>1 mark each (any two)

1 mark each (any two)</td><td>4 M</td></tr>
</table>

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**(c)**	**Explain working of radial gate with the help of neat sketch showing names to component parts of it.** **Ans.** 1) A radial gate has a curved water supporting face made of steel. 2) It is properly braced by a steel framework which is pivoted on horizontal shafts. 3) The gate can rotate about fixed horizontal axis. 4) Hoisting cables are attached to the gate and lead to winches on hoisting platform. 5) The gate is pulled up by using cables and water is released through the gate. 6) It is used for big spans varying from 4 m to 15 m height 3 m to 10 m  	**2 M** **2 M**	**4 M**
	(d)	**Draw a plan and section of a Bandhara Irrigation System.** **Ans.**  **PLAN**	**2 M**	

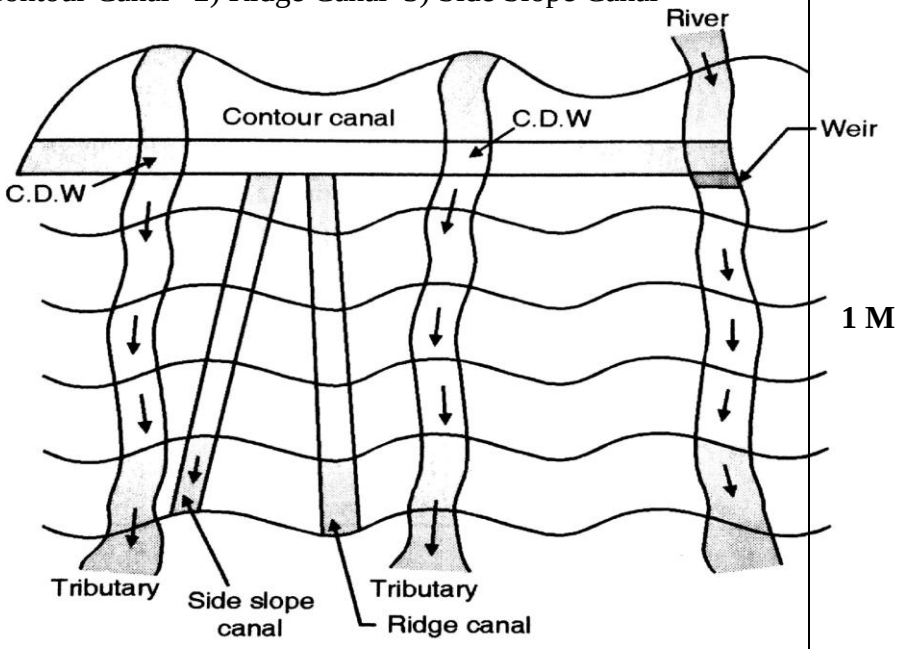
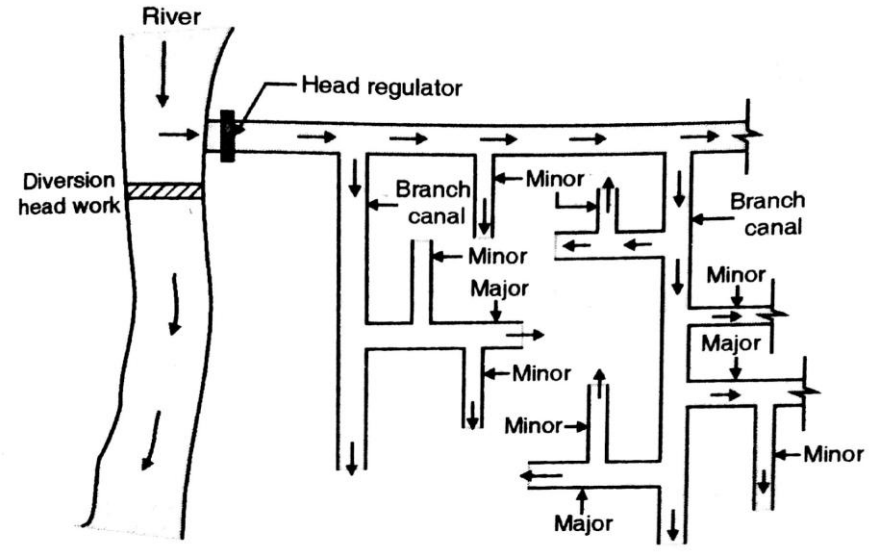
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**(d)**		**2 M**	**4 M**
		SECTION		
	(e)	**Write the need and suitability of site for construction of percolation tanks.** **Ans.** 1) The percolation tanks are constructed where soil is porous and it is not possible to construct the big retaining structures. 2) In percolation tank water percolate through soil pores and joins the ground water which increases water level in wells on downstream side. 3) Thus percolation tanks are suitable where there are more number of wells and bore wells. 4) Useful in areas where other water retaining structures cannot be constructed. 5) The bed of tank should be pervious so that water will percolate and join ground water. 6) The site at which bunds are constructed should have sufficient discharge. 7) The side of stream should be steep	**1 mark each (any four)**	**4 M**
Q.4		**Attempt any THREE**		**12 M**
	(a)	**Explain the functioning of lift irrigation scheme with the help of layout showing components of it.** **Ans.** 1) **Intake well:** A channel is constructed for diverting the flow of water to inlet chamber. 2) **Inlet chamber:** It avoids silts and debris to enter into jack well. 3) **Jack well:** It is provided to facilitates location of an engine house above high flood level and allows pumping during floods. 4) **Inlet pipe:** To convey water from inlet chamber to jack well and inlet pipe is provided with proper gradient. 5) **Delivery chamber:** The water from rising main is collected in delivery chamber and then it is allowed to flow in field ditches.	***½ mark each (any four)***	

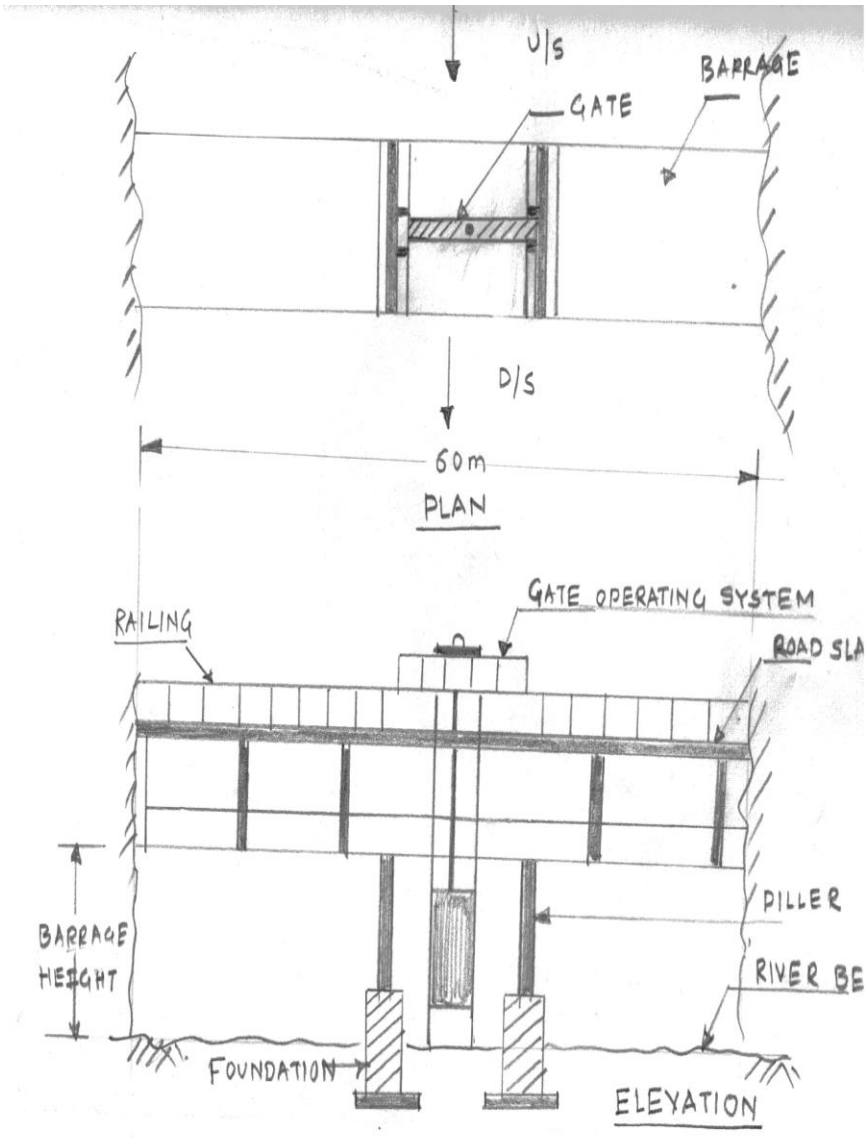
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**(a)**		**2 M**	**4 M**
	(b)	**Describe the operation of drip irrigation with the help of neat layout showing essential component parts.** **Ans.**  **1) Pump unit:** It conveys water from source and provides pressure for delivery into pipe system. **2) Control heads or control valves:** These valves control discharge and pressure of water in complete system. **3) Mainlines, submains and laterals:** Water is pumped from source and conveyed to the fields from the control head through mainlines, submains and laterals. **4) Emitters or drippers:** It is a device by which the discharge of water from lateral to the plants can be controlled.	***2 M*** ***1 mark each (any two)***	**4 M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**(c)**	**Draw the layout of diversion head work and write functions of following components of it:** **i) Head regulator** **ii) Divide wall** **iii) Fish ladder** **iv) Scouring sluice** **Ans.** **i) <u>Head regulator:</u>** 1. It regulate the supply of water entering in canal. 2.It controls the entry of silt into canal 3. it prevents the river flood entering the canal **ii)<u>Divide wall:</u>** 1.To separate flow from the scouring weir which is at lower level than proper weir 2. To separate the silting packet from scouring sluices 3. To prevent formation of cross currents to avoid domain effects 4. To cut off the main portion of the river and provide a comparatively quite packet in front of the canal head regulator resulting in deposition of silt in the pocket and enter clear water in canal **iii) <u>Fish ladder:</u>** 1. To provide free movement of fishes 2. To help the survival of the fishes **iv) <u>Scouring Sluice:</u>** 1. Deposited silt and soil are scoured through the scouring sluice  	***½ mark each (any one)*** ***½ mark each (any one)*** ***½ mark each (any one)*** ***½ mark each (any one)*** **2 M**	**4 M**

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.4</td><td>(d)</td><td>Differentiate between weir and barrage (any four points).
Ans.

<table>
<tr><th>Sr. No.</th><th>Weir</th><th>Barrage</th></tr>
<tr><td>01</td><td>Initial cost is low</td><td>Initial cost of barrage is high.</td></tr>
<tr><td>02</td><td>Area of submergence is more</td><td>Area of submergence is less</td></tr>
<tr><td>03</td><td>The raising and lowering of shutter is not convenient</td><td>The raising and lowering of shutter is convenient</td></tr>
<tr><td>04</td><td>The control over flood is not possible</td><td>There is good control over flood</td></tr>
<tr><td>05</td><td>It is difficult to inspect and repair</td><td>These provides better facilities for inspection and repair</td></tr>
<tr><td>06</td><td>Roadway is not possible across river</td><td>Roadway can be provided across the river</td></tr>
<tr><td>07</td><td>Storage of water is done by crest and very little by gate</td><td>In barrage most of water storage is done by shutter and very less by crest</td></tr>
</table>
</td><td>1 mark each (any four)</td><td>4 M</td></tr>
</table>

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**B) (a)**	**Solve any one:** **Classify the canals according to alignment and position in canal network. Show location plan of each.** **Ans.** **A)Classification based on alignment:** 1) Contour Canal 2) Ridge Canal 3) Side Slope Canal  **B)Classification based on position:** 1) Main Canal 2) Branch Canal 3) Major Distributary 4) Minor distributary 5) Water Course 6) Head Work  	**2 M** **1 M** **2 M** **1 M**	**06** **6 M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**(B) (b)**	**Explain the working barrage with the help of neat plan and elevation proposed across a river having width 60m.** **Ans.** 1) If storage of water is done by gates and very small portion or nil portion of water is stored by raised crest then the barrier is called as barrage. 2) The gate controls the flow of river water depending upon necessity by raising or lowering the gates. 3) Road way is possible to construct across the river with minimum construction cost.  **(Note- Any other relevant figure of barrage should be considered.)**	**2 M** **1 M** **3 M**	**6 M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		**Attempt any TWO.**		**16**
	a)	**Find the design discharge of canal by using following data :**		

Sr. No.	**Name of Crop**	**Area Irrigated (ha)**	**Duty (ha/Cumec)**
1	**Paddy (KH)**	**200**	**600**
2	**Wheat (Rabi)**	**350**	**1200**
3	**Groundnut (KH)**	**600**	**800**
4	**Gram (Rabi)**	**400**	**1700**
5	**Vegetables (Rabi)**	**350**	**700**

Assume :
i) Base period as per season
ii) Transit losses – 15 %
iii) Time Factor – 7 / 12
iv) Capacity Factor – 0.8

Ans.

(1) Taking base period as follows –

Sr. No.	Name of Crop	Base period (B in Days)	Area Irrigated (A in ha)	Duty (D in ha/Cumec)
1	Paddy (KH)	123	200	600
2	Wheat (Rabi)	122	350	1200
3	Groundnut (KH)	123	600	800
4	Gram (Rabi)	122	400	1700
5	Vegetables (Rabi)	122	350	700

(2) Discharge for crops –

$$Q_1 = \frac{A_1}{D_1} = \frac{200}{600} = 0.333 cumec(KH)$$ **1 M**

$$Q_2 = \frac{A_2}{D_2} = \frac{350}{1200} = 0.292 cumec(Rabi)$$ **1 M**

$$Q_3 = \frac{A_3}{D_3} = \frac{600}{800} = 0.750 cumec(KH)$$ **1 M**

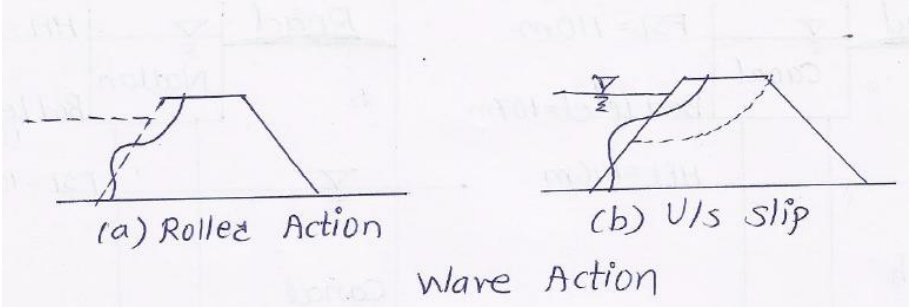
$$Q_4 = \frac{A_4}{D_4} = \frac{400}{1700} = 0.235 cumec(Rabi)$$ **1 M**

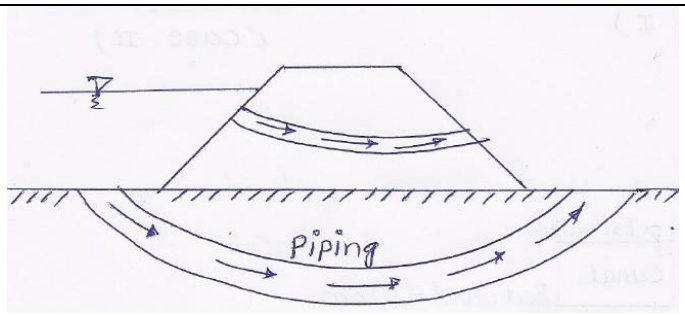
$$Q_5 = \frac{A_5}{D_5} = \frac{350}{700} = 0.500 cumec(Rabi)$$ **1 M**

$$Q_{reqd.}Rabi = 0.292 + 0.235 + 0.5 = 1.027 Cumec$$

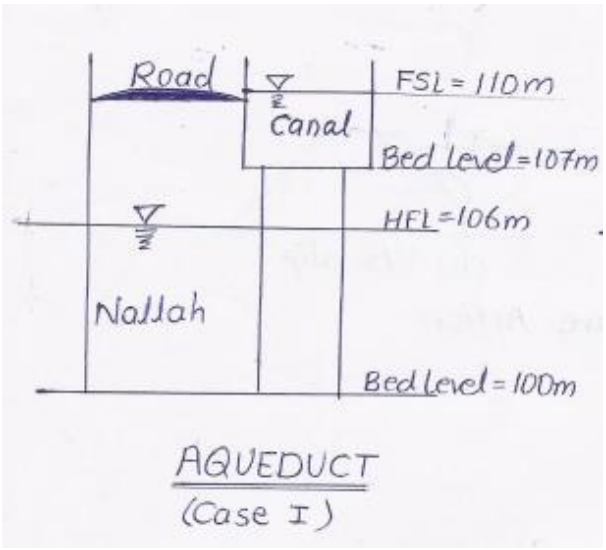
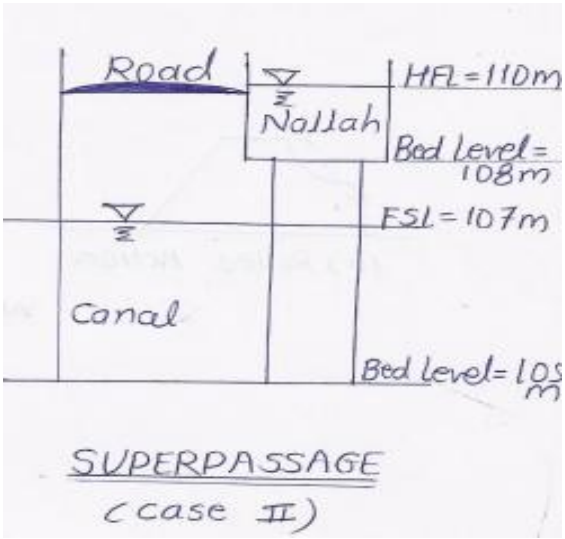
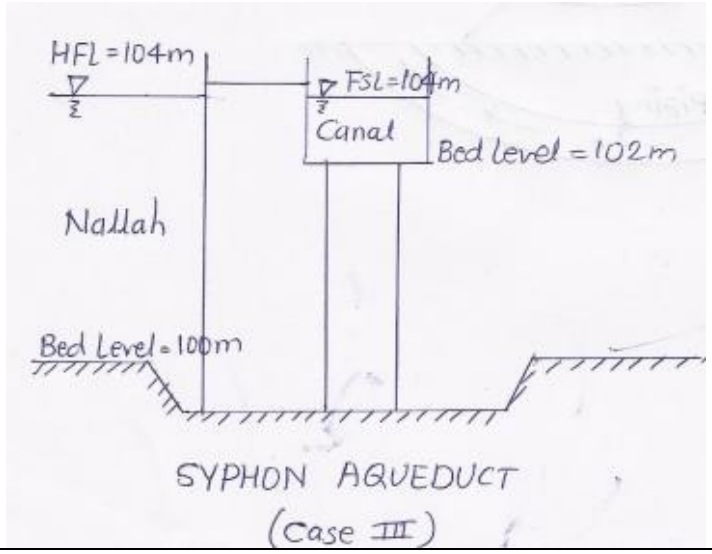
$$Q_{reqd.}Kharif = 0.333 + 0.750 = 1.083 Cumec$$ **1 M**

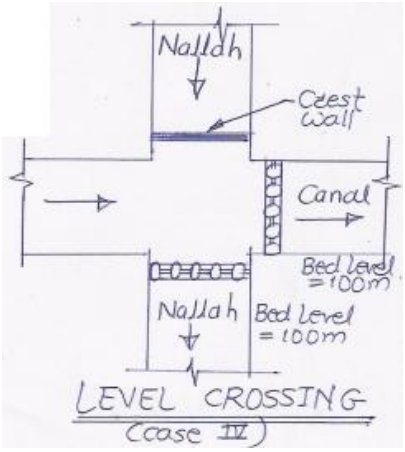
$$Q_{\max} = Q_{reqd.}Kharif = 1.083 Cumec$$

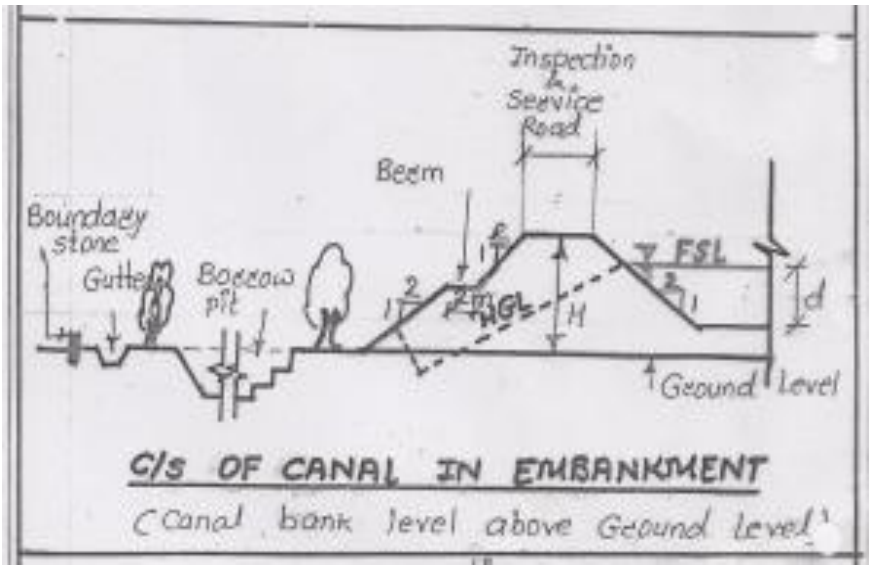
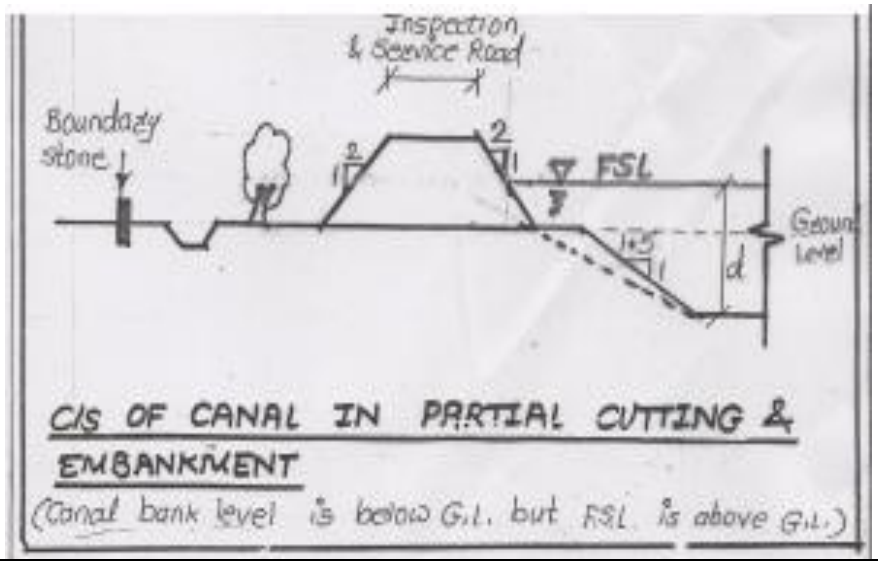
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5		Design Discharge = $\frac{\text{Qmax}}{\text{Time Factor X Capacity Factor X Transit Losses}}$	**1 M**	
		$Q = \frac{1.083}{\left(\frac{7}{12}\right) X\, 0.8 X \left(\frac{100-15}{100}\right)} = 2.730 cumec$		
		Design Discharge = 2.730 Cumec	**1 M**	**8 M**
	b)	**Describe the types of failures of earthen dams & remedial measures.**		
	Ans.	**Ans.** (1) Hydraulic Failure : It may be caused by – a) Overtopping :- If the actual flood discharge is much more than the estimated flood discharge or the free board is kept insufficient or there is settlement of the dam or capacity of spill way is insufficient, then it results in the overtopping of the dam. During overtopping the crest of the dam may be washed out & the dam may collapse. b) Erosion : If the stone protection on u/s side is insufficient, then the u/s face may be damaged by erosion due to wave action. The d/s side also may be damaged by tail water, rain water etc. The toe of the dam may also get damaged by water flowing through spillways.	**2 M**	
				
		(2) Seepage Failure : It may be caused by – a) Piping or Undermining : Due to continuous seepage, flow through the body of the dam & through the sub-soil below the dam. The d/s side gets eroded or washed out & a hollow pipe like groove is formed which extends gradually towards the u/s through the base of the dam. This phenomenon is known as piping or undermining. It weakens the dam & ultimately causes the failure of the dam.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**b)**	 b) Sloughing : The crumbling of the toe of the dam is known as sloughing. When the reservoir runs full, for the longer time, the d/s base of the dam remains saturated. Due to the force of seepage water the toe of the dam goes on crumbling gradually. Ultimately the base of dam collapses. (3) Structural Failure : a) Sliding of side slopes : Sometimes it is found that the side slope of the dam slides down to form some steeper slope. Then the dam goes on depressing gradually & then overtopping occurs which leads to the failure of the dam. b) Damage by Earthquake : The earthquake cracks may develop on the body of the dam . It may eventually collapse. c) Damage by burrowing animals : Some burrowing animals like craw, fish, snake, squirrel etc. causes damage to the dam by digging holes through the foundation & body of the dam. **Remedial measures to avoid failure of earthen dam :** 1) Control of seepage through embankment a) Provide Hearting in the central portion of dam. b) Provide casing over the hearting. c) Provision of horizontal drainage blanket 2) Control of seepage through foundation a) Provide cutoff trench under hearting zone. b) Provide concrete cut-off wall 3) Control of seepage in general a) Provide rock toe on d/s face at toe. b) Provide pitching on u/s slope. c) Provide turfing on d/s slope. d) Provide berms at 8 to 10 m vertical interval on d/s.	**2 M** **2 M** **2 M (Any two)**	**8 M**
	c)	**Suggest & draw line sketch of the type of cross drainage works under following four situations**		

Case	Nallah Bed Level (RL in m)	Nallah HFL (RL in m)	Canal Bed Level (RL in m)	FSL of Canal (RL in m)
I	100,00	106.00	107.00	110.00
II	108.00	110.00	105.00	107.00
III	100.00	104.00	102.00	104.00
IV	100.00	104.00	100.00	102.00

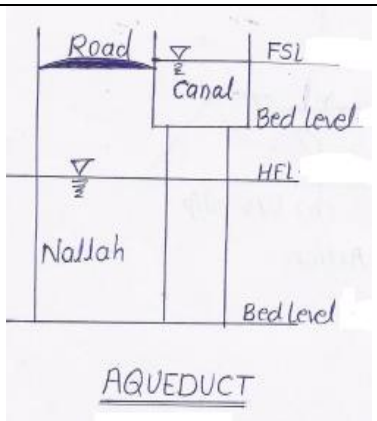
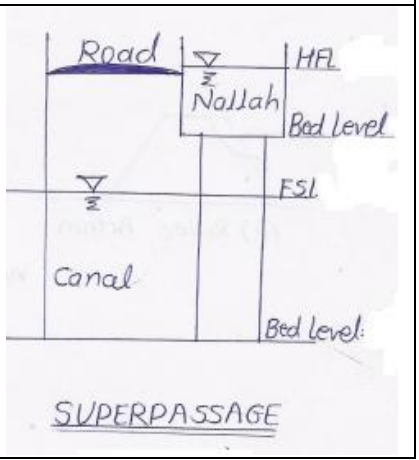
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**c)**	**Ans.** For mentioned condition following type of cross drainage works are suitable –		
		 AQUEDUCT (Case I)	**2 M**	
		 SUPERPASSAGE (case II)	**2 M**	
		 SYPHON AQUEDUCT (Case III)	**2 M**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**c)**		**2 M**	**8 M**
Q.6		**Attempt any FOUR.**		**16 M**
		Explain the construction & operation of KT weir.		
	a)	**Ans.**		
	Ans.	**Construction :** This type of bandhara is commonly constructed in Kolhapur district & hence called K. T. Weir. The sufficient openings are kept in nalla portion so that there is no afflux. Masonry piers with regular grooves are provided with standard opening of 2 m. These openings are blocked by means of needles in two rows filled with paddle in between them. The needles are placed in the grooves provided in piers. The size of wooden needle 15 cm high, 5 cm thick & 2 m in length. These wooden needles are placed into the openings by the fag end of monsoon to store the post monsoon water. It is necessary to restrict the number of openings because of the consideration difficulties involved each time in placing the wooden needles at the fag end of the monsoon & removed of them just before the monsoon.	**2 M**	
		Operation: It is fully open weir. It consists of number of piers & has side grooves for fixing wooden needles. The needles are put across the piers for the required height to form continuous weir. The height can be changed by removing needles or putting additional needles. Needles are removed during floods to avoid rise of water on u/s.	**2 M**	**4 M**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**b)**	**Mention four advantages of sprinkler irrigation over canal irrigation.** **Ans.** Following are the four advantages of sprinkler irrigation over canal irrigation : 1) Erosion of land can be controlled. 2) Uniform application of water is possible. 3) Irrigation is better controlled. 4) Land preparation is not required, hence labor cost is reduced. 5) Small streams of irrigation water can be used efficiently. 6) Fertilizers can be applied in solution form along with irrigation water from the sprinkler. 7) Elimination of seepage & percolation losses thus prevents water logging.	**1 M each (any four)**	**4 M**
	c) **Ans.**	**Draw the cross section of canal in embankment & partial cutting & embankment.**  C/S OF CANAL IN EMBANKMENT (Canal bank level above Ground level)  C/S OF CANAL IN PARTIAL CUTTING & EMBANKMENT (Canal bank level is below G.L. but FSL is above G.L.)	**2 M (sketch, , Labelling)** **2 M (sketch, , Labelling)**	**4 M**

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>6</td><td>d)

Ans.</td><td>Explain four causes & corresponding preventive measures of water logging.
Ans.
<table>
<tr><th>Sr. No.</th><th>Causes of water logging</th><th>Corresponding Preventive measure</th></tr>
<tr><td>1</td><td>Over & Intensive irrigation</td><td>Reducing the intensity of irrigation</td></tr>
<tr><td>2</td><td>Seepage of water from the adjoining high lands</td><td>Providing intercepting drains</td></tr>
<tr><td>3</td><td>Seepage of water through canals</td><td>Lining of canals</td></tr>
<tr><td>4</td><td>Impervious Obstruction</td><td>Providing intercepting drains</td></tr>
<tr><td>5</td><td>Inadequate natural drainage</td><td>Improving natural drainage of the area</td></tr>
<tr><td>6</td><td>Inadequate surface drainage</td><td>Providing intercepting drains</td></tr>
<tr><td>7</td><td>Excessive rain fall</td><td>Provision of an efficient drainage system</td></tr>
<tr><td>8</td><td>Submergence due to floods</td><td>Improving natural drainage of the area</td></tr>
</table></td><td>1 mark each (any four)</td><td>4 M</td></tr>
<tr><td></td><td>e)

Ans.</td><td>Compare between aqueduct & super passage.
Ans.
<table>
<tr><th>Sr. No.</th><th>Aqueduct</th><th>Super Passage</th></tr>
<tr><td>1</td><td>The discharge of drain is more in comparison to canal discharge.</td><td>The discharge of canal is more in comparison to drain discharge.</td></tr>
<tr><td>2</td><td>The bed level of canal is sufficiently above the high flood level in the drain.</td><td>The bed level of drain is sufficiently above the Full supply level in the canal.</td></tr>
<tr><td>3</td><td>Canal runs above the drain.</td><td>Drain runs above the canal.</td></tr>
<tr><td>4</td><td> 
</td><td> 
</td></tr>
</table></td><td>1 M each</td><td>4 M</td></tr>
</table>